

Planting Forest Trees

...on New York Farms



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Contents

	PAGE
Preplanting considerations	4
Purpose	4
Injury risk	5
Site	7
Spacing of trees	9
Pure and mixed plantations	12
Seasons for planting	12
Preparation of planting site	14
Source of planting stock	15
Size, age, and seed source of trees	16
Planting	18
Care of trees prior to planting	18
Tree alignment	19
Planting techniques	19
Hand planting	20
Machine planting	22
Hand planting in mechanically dug holes	23
Replanting	24
Underplanting	24
Interplanting	24
Assistance available	24
Planting stock	24
Aids in tree-planting	25
Aids in fencing the plantation	25
Tax aid	25
Advice	25
Care of plantations	25
Tree species and major enemies	29
White pine	29
Red (Norway) pine	29
Austrian pine	29
Scotch pine	30
Jack pine	30
Larch, Japanese and European	30
White spruce	31
Norway spruce	31
Douglas-fir	31
White Cedar	31
Black locust	31

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FOOD is man's life line; therefore, agricultural crops and pasture should occupy the better farm soils. But much of the remaining land devoted to a well-tended forest is an asset to any farm. Many farms have land too steep or rocky for cultivation, too poor in nutrients and moisture for good crops, or fields too small, irregular, or distant for intensive farming where trees may thrive and produce a useful future crop. All land too poor for agriculture, however, should not be reforested; poorly drained soils often grow no better trees than other farm crops.

Planted forests require considerable time to produce a crop, although merchantable timber is often grown within a man's lifetime. Christmas trees are sometimes

cut in less than ten years. Also, much of the wood cut out in the periodical thinning of the forest is useful, and the remaining trees are given needed space in which to grow. Aside from future commercial returns, trees are planted to hold the soil on steep slopes, to prevent wind erosion, to act as a windbreak, to establish game cover, and to add beauty to the landscape.

Broadleaf deciduous trees, commonly called *hardwoods*, are not generally recommended for reforestation. They have usually met with failure in past plantings. White ash, red oak, basswood, black walnut, sugar maple, and especially black locust have been planted. Hardwoods require better soil than most conifers, they are damaged more severely by rodents and browsing animals, and they require special soil preparation before planting. Black locust for fence posts has met with some success on well-drained soil where the calcium level is high.¹

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¹ *Black Locust for Posts*, by J. A. Cope, Cornell Ext. Bul. 539, 1942.

Other Cornell bulletins give recommendations for hardwood plantings and Christmas-tree farming.² Therefore this bulletin discusses coniferous plantations for wood production, for the control of soil or wind erosion, for game cover, or for natural beauty.

Trees selected for forest planting must be:

1. Useful for the contemplated purpose of planting.
2. Not susceptible to uncontrollable damage by insects and fungi.
3. Suited to the conditions of the planting site with due regard to the trees' natural characteristics.

(The number of species known to be successful is quite small.)

Preplanting Considerations

Purpose

If **lumber** is the product desired, your chief consideration is a good yield to the acre of species that have the required wood characteristics. Trees differ in ability to grow under shade. Those that demand full light, can maintain fewer trees to the acre and hence yield less material at maturity; thus the shade-intolerant larches³ produce less volume per acre than the shade-tolerant spruces. Shade-intolerant trees on the other hand often achieve greater volume in individual trees in the same length of time. Among the conifers, the soft, easily worked woods, which hold paint well or finish beautifully, usually bring the highest price. Pines are

valued above other conifers for these reasons, and the white pine leads all other pines.

For **pulpwood**, species that produce a large volume per acre are preferred. Many pulp mills pay a premium for species that have long fibres, low pitch content, and high density. These characteristics are found in the spruces more than in other species. Ordinarily, trees are not planted solely for pulpwood because the mill demand for species changes and thinnings can be sold for this purpose.

For **poles, fence posts, and grape stakes**, the species selected should be those that either have naturally durable heartwood or are easily impregnated with wood preservatives. Black locust has extremely durable heartwood, while the pines are most easily treated with preservatives. Except for black locust, plantings are not usually made for these products alone. Thinnings from plantations destined for other

² *Plantations of Northern Hardwoods, Some Factors Influencing Their Success*, by E. F. Wallihan. Cornell Univ. Agr. Exp. Sta. Bul. 853, 1949. *Christmas Tree Farming*, by J. A. Cope and F. E. Winch. Cornell Ext. Bul. 704, 1954.

³ All references to larch will be to the European and Japanese larches.



Figure 1. This four-row Norway spruce windbreak provides wind protection to the farm buildings and keeps snow from drifting into building area.

uses ordinarily supply these small wood products.

In planning for a **Christmas tree crop**, you must keep in mind the fluctuation in demand for certain species. All of the conifers used in reforestation in New York State, except the larches and white cedar, have been used for this purpose. At present, Douglas-fir, Scotch pine, and white spruce are most valued.

For protection from wind throughout the year, evergreens with fairly dense foliage, such as spruces and cedars, are preferable.

For soil protection, usually the fastest growing trees, and those that can tolerate adverse conditions, are planted. Depending on soil conditions, red, Scotch, or jack pine are planted. Where erosion

is extreme or extensive, use shrubs and other plants recommended by the local Soil Conservation Districts.

Species for a specific product or purpose, arranged in approximate order of preference, are listed in table 1. These species do not necessarily exhaust the list. As forest planting experience in the State increases, other trees may be used.

Injury Risk

Insects, fungi, or other tree pests may prevent your choice of certain useful trees, either locally or throughout the State. The most notable example is the white pine weevil. Locally, deer, squirrels, mice, and other wildlife may be a hazard to certain species. Climatic conditions may also injure some

Table 1. Trees for Planting, Classified According to Purpose

Lumber	Pulpwood	Posts and Poles	Windbreaks	Soil Erosion	Christmas Trees
White pine	Norway spruce	Black locust	Norway spruce	Jack pine	Douglas-fir
Red pine	White spruce	White cedar	White cedar	Scotch pine	Scotch pine
Austrian pine	Larch	Others, if treated:	White pine	Red pine	White spruce
Norway spruce	Red pine	Red pine	White spruce	Black locust	Austrian pine
White spruce	Austrian pine	Austrian pine	Austrian pine	Various shrubs	Norway spruce
Larch	Scotch pine	Scotch pine	Red pine		Red pine
	Jack pine	Larch	Douglas-fir		
	White pine	Jack pine	Scotch pine		
		White pine			

Figure 2. Soils vulnerable to wind erosion may be held by reforestation. This Scotch pine planting will soon prevent further soil movement.



species. Douglas-fir, larch, and Norway spruce are susceptible to late spring frosts and should not be planted in frost pockets or in other areas of poor air drainage.

The chief hazards are discussed in more detail under each species on pages 29 to 31.

Site

Because trees formerly covered the land is no assurance that they will still grow well anywhere. Many years of cultivation or erosion may have removed so much topsoil that not enough remains over the clay or rock subsoil for good root development. In addition, the natural drainage pattern has been upset by road building and agriculture. Soils grade from good to poor

in forest-producing power just as they do for field crops. The least productive are the very thin, rocky soils and the wet, cold, poorly drained ones. Norway spruce does not grow well on the very thin, rocky soils and red pine dies at an early age on the wet, cold, poorly drained soils. Most other trees make poor growth at best on such sites.

Choice of site is most important if you plan to grow timber crops. There are numerous examples of the same tree species growing from 200 to 400 percent more lumber on one site than on another. Furthermore, the logs are larger and the lumber more valuable on the good site.

A tree's needs for soil fertility, and especially for soil moisture,

Figure 3. Species classified according to soil moisture

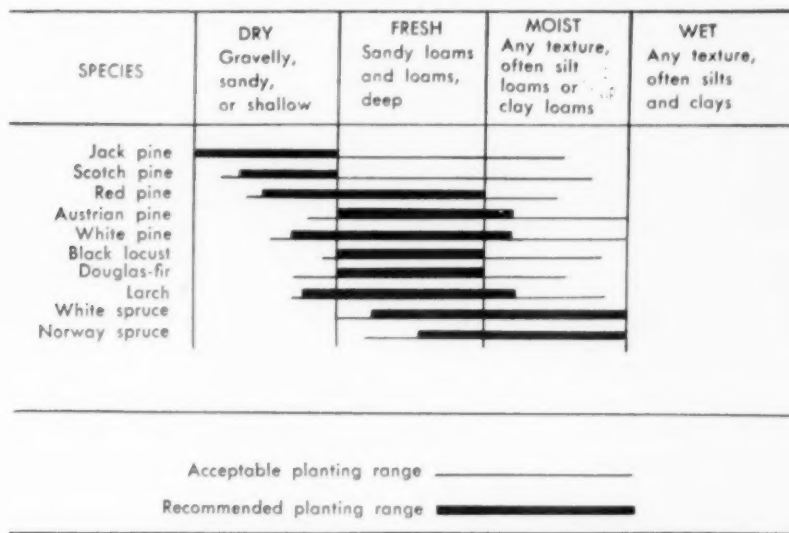




Figure 4. Faulty selection of species to suit the site is here illustrated by stagnating and dying red pine on poorly drained Volusia soil. Trees are at least 18 years old. Note the "tufted" appearance of foliage.

will guide you, the planter, in choosing species that are suited to your proposed planting site. The range in soil-moisture requirements of different trees, together with emphasis on the recommended range for forest-tree planting, are given in figure 3. Trees that need the most moisture usually need also the most nutrients and often are the most tolerant of shade.

Never confuse soil moisture with soil drainage. There is a great difference among trees in soil moisture requirements, but few trees can stand poor drainage. For ex-

ample red pine, larch, and white pine grow well on moist loam or clay loam if the drainage is good. If drainage is impeded at depths of less than 18 inches, poor growth and even death of the tree may be expected. Most trees need at least 3 feet of well-drained soil for maximum volume production.

Poor soil drainage can sometimes be predicted from soil maps, but it is easy to determine at the proposed planting site. Dig small holes 18 inches deep every 100 feet or so throughout the field, preferably in the spring. Soil that is yellow, brown, or red in color is usually well drained. Soil that is gray or black or "wet looking," or where water seeps into the hole is poorly drained. Poor drainage is also indicated by a clay hardpan or subsoil often "mottled" with bright colors at depths less than 18 inches.

The planting of brushy land presents something of a dilemma. Usually the best policy is to plant a fast-growing intolerant species, such as larch, that is capable of height growth up to 3 feet a year in early life. Poisoning or repeatedly cutting back the brush should enable the planted trees to dominate the site within a decade. Where brush cover is not dense, shade-tolerant spruces may be planted. After the spruce has become firmly established, you must poison or cut the overhead brush.

More detailed information on the site requirements of individual species is given on pages 29 to 31.



Figure 5. Fast-growing Japanese larch planted under scrubby, worthless hardwoods. The brush and hardwood trees have been chemically killed.

Spacing of Trees

After you have selected a species that will yield the end product you want and have found a suitable growing site for the species, then you must consider the outlay of time and money necessary to see the planting develop into a forest. In addition to planting costs, there are costs for thinning and pruning the growing forest. These depend largely on the species, the site, and especially the spacing of seedlings in the plantation.

In the past, most trees were planted 6 by 6 feet. Recently red pine and larch have usually been planted 8 by 8 feet. This rule of thumb is not suitable for all plan-

tations. Where the planting is made for the production of commercial tree crops other than Christmas trees, the major considerations that influence spacing are the following:

1. Market for small wood

Trees planted 6 by 6 feet apart usually require thinning when from 15 to 20 years old. Most of the trees removed will be no more than 4 inches in diameter. Markets for such small wood are few. Christmas trees, fence posts, and wood chips are possibilities. It is often desirable to space the trees wider than 6 by 6 feet. The smallest spacings that allow trees to grow to certain sizes by the time the first thin-

Table 2. Minimum Plantation Spacing Required to Yield Trees of Various Diameters When the First Thinning Is Needed^a

Site	Species	Minimum diameter (inches) of cut trees					
		4		6		8	
		Spacing	Trees per acre	Spacing	Trees per acre	Spacing	Trees per acre
Deep, well-drained, fertile soils	Norway spruce	Feet 4 × 4	Number 2,720	Feet 6 × 6	Number 1,210	Feet 8 × 8	Number 680
	White pine	4 × 4	2,720	6 × 7	1,040	8 × 9 ^b	600
	Red pine	4 × 5	2,180	7 × 7	890	9 × 9	540
	Scotch pine	5 × 5	1,740	7 × 8	780	10 × 10 ^c	440
	Larch	5 × 6	1,450	8 × 8	680	10 × 11	400
Medium Soils	Norway spruce	5 × 5	1,740	8 × 8	680	10 × 11	400
	White pine	5 × 6	1,450	8 × 9 ^b	600	11 × 11 ^d	360
	Red pine	6 × 6	1,210	9 × 9	540	12 × 12	300
	Scotch pine	6 × 7	1,040	10 × 10 ^c	440	13 × 13 ^e	260
	Larch	7 × 7	890	10 × 11	400	14 × 14 ^f	220
Shallow, poorly drained, impoverished soils	Norway spruce	7 × 7	890	10 × 10	440	These soils ordinarily should not be planted for timber crops. Plant for wildlife, soil protection, or scenic purposes only.	
	White pine	7 × 7	890	11 × 11	360		
	Red pine	8 × 8	680	12 × 12	300		
	Scotch pine	9 × 9	540	14 × 14	220		
	Larch	10 × 10	440	15 × 15	190		

^a Based on data from Lewis County presented in report to New York Section, Society of American Foresters, 1952 Summer Meeting, by M. J. Farree, State Univ. Coll. of Forestry, Syracuse.

^b Assumes 90 percent planting survival.

^c White pine normally planted no wider than 6 by 6 feet because of white pine weevil.

^d Other considerations normally dictate somewhat closer spacing.

ning is needed, for one area of the State, are given in table 2. Accordingly, if wood of 6-inch size is needed from the first thinning, trees can be planted from 6 to 8 feet apart on only the best soils. Medium quality soils require wider spacing.

2. Objectives of tree growing

Close spacing (6 by 6 feet) tends to make straight stems with little taper, small branches, and narrow growth rings. Pruning is easy, and the wood is dense and strong. Such wood makes high-quality poles, pulpwood, and lumber. A high price is needed to compensate for costly thinnings and the long growth period. Close spacing also gives the grower many more trees to choose from, so that the very best individuals can be selected as a crop.

Wide spacing (10 by 10 feet or more) makes fast-growing trees with considerable taper until the tree crowns are well closed. The large branches that develop may double pruning costs. Early pruning of live branches before they get too coarse decreases costs and improves the quality of the lumber. Widely spaced trees grow fast, require little investment in planting and thinning, and yield commercial products at an early age. Wood quality is not so good, however, and a lower price may be expected. Excellent survival is necessary, especially on the poorer soils, or you may need expensive replantings.

Modern technology finds more and more ways to take poor quality wood and make high-quality products from it. The trend seems to be toward using more and more low-quality wood. There is also a reverse trend toward higher prices for the very best wood. The owner's objectives should depend on location of mills, labor costs, and his own use of wood products.

3. Site

As shown in table 2, trees grow closer together without stagnation on good deep soil, especially in humid regions. Root competition is greater in poor soils and the trees should be planted farther apart. Planting sites directly exposed to strong prevailing winds (usually at high elevations) need fairly close spacing to prevent the development of extreme taper. On good accessible sites, you may space the trees fairly close and grow high-value trees. If the land is poor or difficult to reach, or if you are not likely to thin and prune, space the trees farther apart.

4. Species

Shade-tolerant trees, such as the spruces, can be planted closer together than the intolerant larches and pines (table 2). Special tree characteristics may influence spacing. Plant tree species that are susceptible to serious injury by insects, disease, or other pests fairly close together. For example, widely

spaced plantations of white pine might well have the majority of the trees badly deformed by the white pine weevil. The normally straight-growing red pine and larch, on the other hand, often perform well at wide spacings.

5. Harvest

Arrangement and spacing influence the harvesting of trees. Closely spaced plantations do not lend themselves to easy thinning operations. A spacing of 6 feet between rows scarcely permits the passage of a horse, much less a farm tractor or other skidding equipment. Unless there is a sound reason for doing otherwise, do not plant the rows closer than 8 feet. There is nothing that demands trees be put in at "square" spacing. If close spacing is necessary, trees may be planted 5 by 8 feet rather than 6 by 6 feet, and still provide for better access.

Pure and Mixed Plantations

A pure plantation of one species only is simpler to plant, to manage, and to harvest than a planting of two or more species. Pure plantations are more common in the State and are generally to be recommended in preference to mixed plantations.

In large plantations of 15 acres or more, mixed planting may safeguard the plantation from partial or total loss in case one species is attacked by insects or fungi. Many of the mixtures planted in the past

have had white pine as one of the components, often being planted with red pine. In some forests this was fortunate, for when the weevil deformed the white pine, the red pine provided enough uninjured stems to produce a successful plantation. On the other hand, the species chosen for mixture too often were not equally adapted to the planting site, so that one soon overtopped the other.

Perhaps the best reason for mixed planting in small plantations is to help the final spacing of trees. This is done by planting a species to be removed early for some special product while another species is left for timber growth. It is best to plant from 300 to 500 trees for timber growth, but the number of "filler" trees may vary according to the purpose and site.

Examples are:

Spruce removed early for pulp;
pine left for timber

Christmas trees removed early;
other trees left for timber

If your planting area has a patchwork pattern of different soil conditions, plant small blocks of trees of the proper species on each site. This is much better than pure plantings which ignore the soil difference or mixed plantings made in the hope that enough trees will be successful.

Seasons for Planting

Spring is the most favorable time to plant forest trees. Planting, especially larch, should be done as



Figure 6. A mixed plantation of red pine and spruce. On this well-drained site, the growth of the pine has surpassed the spruce and is gradually forcing the spruce out.

soon as the frost is out of the ground and the soil can be worked easily. The best and most favorable conditions for growth are usually found during the first few weeks of the growing season. At this time the roots are active and become quickly established. There should be no more delay than is necessary between the time when the trees leave the nursery and when they are permanently established on the planting site. Planting should always be finished as early as possible in order to have the benefit of spring rains. Conifers can stand planting after growth has started, though this may result in breakage of new tips and in a high mortality if dry, windy days follow. Spring planting is practicable on all kinds of soil. It should be completed, in most parts of the State, early in May, although in the northern counties planting may be carried on successfully during the whole month. The period depends on the location and whether the season is advanced or delayed.

After autumn rains have replenished the moisture in the soil, fall planting may be undertaken on the lighter, more open, porous soils, and on protected sites where early permanent snowfall is expected. However, heavy, moist soils exposed to alternate freezing and thawing may heave, resulting in the loss of many trees. On exposed sites with little snow, evergreens may be desiccated by drying winter winds. The southern and west-

ern parts of the State have a great many soils subject to frost heaving, and sometimes little snow cover. Fall planting is not recommended in these regions.

Preparation of Planting Site

Coniferous seedlings generally survive and grow well without ground cultivation. Indeed, such preparation may result in increased frost heaving on heavy soils or accelerated erosion on steep slopes. In general, soil cultivation is an unnecessary expense and not warranted by what little benefit may be gained.

There are, however, some exceptions, and ground preparation is advisable. Planting of trees in the bottom of a shallow plowed furrow on **well-drained sandy loam** has sometimes resulted in better survival and initial height growth. The plowing of single or double furrows is recommended for black locust to remove grass competition. On hills, any furrows should be plowed on the contour.

On **imperfectly drained soils**, two furrows thrown together in early fall to make a ridge on which to plant in the following spring, create better conditions for tree growth. The ridges are more fertile from the double layer of sod, the soil is better aerated, and the competition of heavy sod typical of these soils is reduced. On hills, these ridges should be made with a drop of 5 feet in every 100 feet to carry off excess water. Early

growth of spruce has especially benefitted from planting on ridges. Ridge planting requires great care in setting the trees, and heavy mortality may follow extreme drought on exposed planting areas.

On **poorly drained soil** where the hardpan is within 18 inches of the surface, it is doubtful whether furrowing will make timber growing possible. Early growth of trees planted for short-term crops may be improved in some instances. A single furrow, from 10 to 12 inches deep and thrown downhill, should be made with a drop of 5 feet in 100 feet. Where much heavy clay is turned up from the bottom of the furrow, losses from drought or frost heaving are increased. Such heavy clay requires two or three years exposure before it is properly broken up, suggesting that plowing should be done at least two years before planting.

Planting sites that are occupied by brush or undesirable tree growth, such as gray birch or poplar, demand vigorous action if the area is to be converted to a successful plantation. The choice of species for such sites has already been discussed. Either before or after planting, remove or kill the brush or undesired trees. In doing battle with these woody plants, chemical herbicides are the best weapons. They are far easier to use than cutting methods and, when properly applied, reduce sprouting. Special care must be exercised to prevent damage to planted seed-

lings if the planting is done first.

The most useful chemicals are 2,4-D and 2,4,5-T mixed in oil or water.⁵ Use water and oil solutions as foliage sprays to cover the whole plant in the summer. Use oil solutions as basal sprays to cover the lower stems of trees up to 5 inches in diameter at all seasons of the year. Larger trees may be girdled or treated by injecting chemicals into cuts in the bark. If you wish to cut and remove the undesired woody plants, apply the chemicals to the **fresh-cut** stumps to prevent sprouting.

Source of Planting Stock

Nursery-grown trees are most suitable for forest planting on New York farms. Although wild seedlings or direct planting of seed have been used with success under certain favorable conditions, these are not generally recommended.

The New York State Conservation Department⁶ maintains two forest-tree nurseries. The trees grown in these nurseries are sold to New York landowners at a very nominal charge, ranging from \$2 to \$4 per thousand trees. At present, there is no charge made to Forest Practice Act⁷ cooperators for trees

⁵ *Killing Undesirable Woody Plants With Chemicals*, by L. S. Hamilton and R. R. Morrow. Cornell Department of Conservation Mimeo Leaflet 9, 1955.

⁶ *Forest Planting in New York*, by E. W. Littlefield. New York State Conservation Dept. Forestry Bul. 2, 1953.

⁷ *The New York Forest Practice Act*, by E. W. Littlefield. New York State Conservation Dept. Forestry Bul. 21.

to be used for forest production. None of the trees are more than 4 years old. Most of the trees mentioned in this bulletin are available for public distribution in lots of not less than 1000 of each species. To procure trees, you should obtain an order blank from the District Forester, County Agent, Extension Forester, Soil Conservation Technician, or from the New York State Conservation Department at Albany, fill it out completely, and send it to your District Forester. Trees for spring planting should be ordered soon after July 1 of the previous summer because of the Conservation Department's policy of filling orders on a "first come, first served" basis. If you wait until the first mild weather in February to start thinking about ordering trees, you may find that the trees you want are gone.

A number of reliable commercial nurseries also handle stock for planting. The larger firms can usually furnish a variety of species in any quantity, and also trees in sizes and ages greater than those available at the state nurseries. The prices at the private nurseries naturally are considerably higher than those from the state nurseries.

At the nursery, the trees are wrapped in bundles, then firmly packed with damp moss to protect the roots. Even so, the roots dry out rather quickly, and shipment by express or truck is advisable. Transportation charges must be paid by the purchaser. The stock should not

be allowed to remain packed in the containers longer than is absolutely necessary, but should be "heeled in" or planted upon arrival.

Size, Age, and Seed Source of Trees

In the past, conifers were usually grown two years in seedbeds, then transplanted or "lined-out" to grow one or two more years, producing large and well-balanced plants, called *three-year* or *four-year transplants*. Three-year, four-year, or even older and larger transplants may still be obtained from commercial nurseries. New York State Conservation Department nurseries, however, have discontinued the transplanting of seedlings because of the excessive labor costs. They now produce for general distribution only two-year, three-year, and in some cases four-year old seedlings, and control the size of the plants largely by regulating the density of seeding in the seedbed.

Some Conservation Department seedlings are shown in figures 7 and 8. Three-year seedlings are best for most planting sites and techniques of planting. Machine planting is best conducted with large, uniformly sized, three-year seedlings. Three-year or older stock is also preferred over two-year stock for windbreak and Christmas-tree planting and for any planting in heavy sod or heavy weed competition. In general, three-year stock is more easily planted and gives the plantation a better start. Black lo-

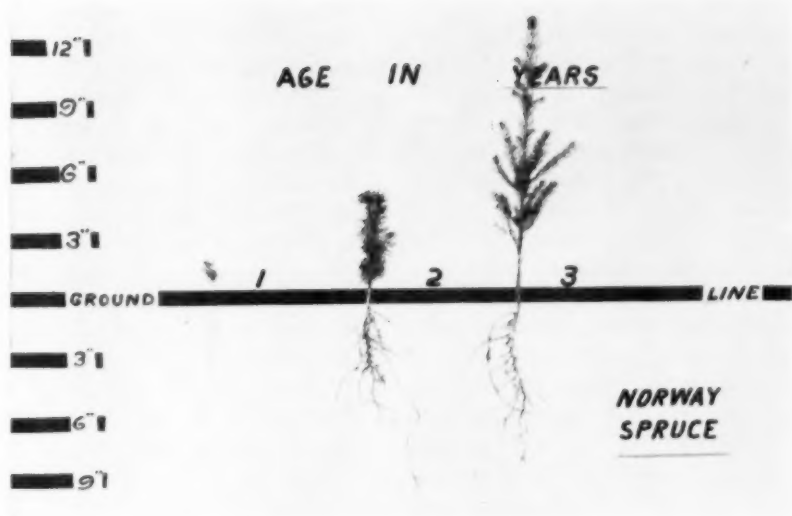
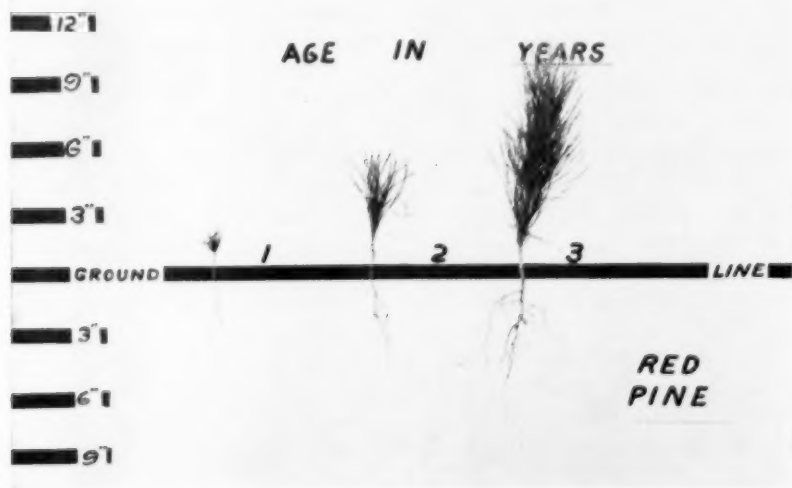


Figure 7. Norway spruce stock of different ages

Figure 8. Red pine stock of different ages



cust and larch are exceptions, for one- and two-year seedlings, respectively, of these species are usually large enough for planting under all conditions. The cheaper two-year seedlings of other species may be used to hand-plant sites where ground vegetation is sparse or on stony sites where it is difficult to make deep holes for the roots. Even here, three-year spruce planting stock should be used. Regardless of seedling size and age, it is best to have a good balance between size of the tops and roots.

The source of the seed (parentage and location) has an important influence on the performance and the subsequent use of plantations. In general, both public and private nurseries attempt to obtain seed from sources which are known to produce trees with desirable characteristics. Sometimes it is possible to obtain seedlings of one species from two or more different seed sources. For example one "variety"

of Scotch pine has blue-green foliage and is preferred for Christmas trees; another has yellow-green foliage and straighter stem form and is preferred for wood production. Likewise Pacific Coast Douglas-fir is unsuited to New York, while Rocky Mountain or Interior British Columbia strains may be used. The superiority in performance of certain strains of the European larch (Cranston, Sudeten) has been well demonstrated by E. J. Eliason and D. B. Cook of the New York State Conservation Department. You should obtain these strains even if the seedlings cost more originally. In general, the Conservation Department nurseries produce planting stock from seeds which are known to be suitable to New York climatic conditions. In obtaining seedlings from commercial nurseries, especially those in other States, there is a risk of getting seedlings that are not suited climatically for best growth in this State.

Planting

Care of Trees Prior to Planting

THE nursery will notify you when your order of trees has been shipped, and you should be ready to receive them immediately upon their arrival. Take the crates at once to the planting site. Dig a trench in a shady, moist area which is long and deep enough to accommodate the seedlings. Unpack the trees, cut the strings around the

bundles, and "heel in" the trees. If the roots seem dry, wet but do not wash them with water. The roots must be protected at all times from drying out.

By "heeling in" is meant the temporary placing of the trees upright in a trench, and the packing of soil firmly around the roots to keep them moist. Locate the trench in loosened, well-drained soil. It should have one slightly sloping

even side, and it should be deep enough to prevent any bending of the roots. Spread the plants out along the side of the trench. Pack a layer of soil against the roots, and spread another layer of trees out on this after you have made a trench parallel to the first one. Continue this until all the seedlings are cared for. Pack the soil tightly around the roots and lower stems. If exposed to the sun, cover the tops loosely with evergreen boughs or otherwise shade the tops to prevent excessive loss of moisture. Water the seedlings if necessary during the period of heeling in. They may remain in these trenches for two weeks without injury, provided they are properly heeled in, and they may be removed for planting as needed.

Tree Alignment

Straight rows can best be made by using flags on poles. Four flags on poles equal in length to the spacing distance between rows are needed for each planting crew. Two flags are used at each end of the field to be planted. In starting off, set two flags from 30 to 60 feet apart, in line on the first row and at the end of the field opposite the starting point. You can determine whether you are on line by standing so that the two flags are directly in line. Before starting down the row, set the two flags for the second row, using the length of the poles to give the proper row spacing (for example, for rows 8 feet

apart, use 8-foot poles). At the conclusion of planting each row, move the flags over two rows to be ready for the return trip. Spacing within the row is usually determined by pacing in hand-planting or by rhythm in machine planting.

Row direction should be determined with due regard to existing roads and topography which will influence the efficient use of harvesting equipment. In plantations of 5 or more acres, you can leave room for roadways by not planting two or three rows of trees. An access to the plantation is often overlooked until too late.

Planting Techniques

To assure the survival of a stand of high-quality trees, set the trees in the ground in an upright position, at the same depth at which they grew in the nursery beds, with the roots spread out as much as practical, and with the soil packed firmly about the roots. The depth at which the trees grew in the nursery is generally recognizable by a change in appearance on the stem. If there is any doubt, err on the side of planting a little deeply, but not more than 1 inch deeper than the normal level. With most species, this deeper planting is quite satisfactory, especially on sandy soils; with spruce, however, it is advisable to take special pains to set the trees at the correct depth. Plant only one tree in each hole.

Keep the roots moist at all times.



Figure 9. When this tree was planted, the roots were balled up in the hole rather than being spread out.

Wet moss or mud in the carrying pail is preferred to plain water. Remove trees, one at a time, from the pail.

Hand planting

In spite of all the specialized tools designed to make holes or slits in the ground for tree planting, the mattock or grub hoe still holds top place for most New York planting conditions. The mattock-slit method is simple, fast, reliable, and adapted to all soils except those that are excessively stony or very sandy. Strike the blade of the mattock full depth into the ground,

keeping the handle parallel with the ground (figure 10). Raise the

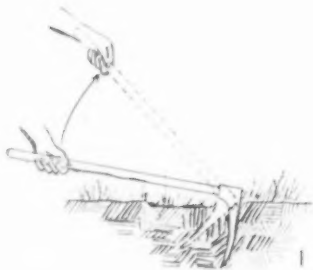


Figure 10. Strike blade full depth into ground.

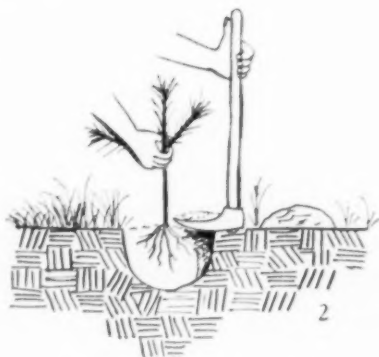


Figure 11. Open slit or hole.



Figure 12. Tamp firmly with heel.

handle and, with the same motion, twist it slightly to one side to open a slit along one side of the mattock blade (figure 11). "Whip" the tree roots into the slit so that the roots are spread, hold the tree at the correct depth, and allow the soil to slip back into place by removing the mattock. Tamp the soil *firmly* into place with the *heel* as you move forward to plant the next tree (figure 12).

In sandy soils trees may be planted in vertical slits made with a spade, shovel, or planting bar. Push the blade into the ground to its full depth. Open a slit by moving the handle backward and forward. "Whip" the tree roots into this slit and hold it at the correct depth.

Insert the blade of the planting tool again about 3 inches from the first slit, and by pushing and pulling the handle, firm the earth against the tree roots. Fill in the second slit by tamping, and pack the ground around the tree with the heel.

In very stony ground, almost any technique of making a hole or slit, planting the tree at the correct depth and getting the soil back around the roots is acceptable.

Whichever method of planting you use, test the firmness of the earth-packing job by grasping the tree by the top and tugging at it lightly. Trees that loosen easily are not properly planted and should be replanted.

Figure 13. Hand planting with a two-man crew, using the mattock-slit method



The rate of hand planting varies with the efficiency and stamina of the planters, with the terrain, soil conditions, natural vegetation, weather, and the size of planting stock. One man can perform all the planting operations, but a two- or three-man crew is more efficient. A two-man crew with little or no previous experience should be able to plant from 700 to 1200 trees per 8-hour day. A three-man crew should plant an average of 1200 to 1800 trees a day.

Machine planting

Tree-planting machines open a trench or slit and pack the earth around the tree roots, thus eliminating the two most difficult and time-consuming jobs in planting. The planter rides on the machine, removes the seedlings from their container, and holds them at the correct depth in the trench or slit

until the earth closes around them. On some machines there is provision for two "riders," one to sort out the trees and hand them one by one to the planter. The packing is generally accomplished by the weight of the machine and rider or riders, delivered through two packing wheels which run each side of and close to the planted tree.

The three basic kinds of planting machines are designed as described in the following paragraphs.

The "floating" type is one which is attached to the tractor drawbar in such a way that it can be lifted entirely off the ground by the hydraulic lift mechanism of the tractor. The depth of slit is governed by the lift mechanism of the tractor. This type of machine is able to make short-radius and rapid turns at the end of each row.

The "semi-floating" machine has

Figure 14. A tree-planting machine of the "floating" type



the front end carried by the tractor but its back end carried on wheels that cannot be lifted entirely off the ground by the tractor. Depth of slit is governed by the hydraulic lift mechanism of the tractor. A tractor with power lift and 3-point suspension is required to carry the machine.

The "trailer" type has its own wheels or runners carrying all of its weight. The tractor merely pulls the machine along. The turning ability of these machines at the end of the row is not so good as the others, but they are generally built more ruggedly and can be pulled by a variety of equipment ranging from jeeps to crawler tractors. Depth of slit is governed by levers or hydraulic mechanisms on the planting machine itself. Usually, these machines are the most expensive.

Commercially made machines of these three types are available at a cost of from \$200 to \$750. They might well be purchased on a cooperative basis by groups of landowners or by organizations, such as Watershed Associations or Soil Conservation Districts, in those areas where there are large blocks of trees to be planted on land which is not too steep nor too stony for the machine to operate. Planting rates up to 8000 trees per 8-hour day have been attained with these machines under good conditions. A number of homemade tree-planting machines have been built and used successfully. They have

generally consisted of some sort of modification of a single- or double-bottom plow.

Hand planting in mechanically dug holes

Holes for tree planting may be made with lugs mounted on either a wheeled tractor or a crawler tractor. For wheeled tractors, a lug may be welded on one end or both ends of a length of angle iron which is bolted across the rear wheel of the tractor (figure 15). The lug projects 5 to 6 inches beyond the tread of the tire and scoops out a clump of sod. Tractor wheels with a 12-foot circumference are thus able to dig holes every 6 feet when lugs are put on both ends of the bar. Plans for this inexpensive attachment are avail-

Figure 15. Planting bar mounted on a wheeled tractor



able from the Department of Conservation at the New York State College of Agriculture, at Ithaca, New York. With crawler tractors, lugs may be bolted onto the tracks to give the desired spacing of the holes. The depth of the hole is determined by the height of the lug. The tree should be placed against the vertical back of the hole, the clump of sod replaced, and tamped firmly. Trees should be planted as soon as possible after the holes are dug so that the soil does not dry out.

Replanting

In years of normal weather, the loss of planted trees should not exceed 10 percent if your planting is well done. If losses exceed 25 per cent, you should probably replant the failed areas within two or three years. This is especially important if the trees are spaced wide. If, however, most of the losses are in the same part of the plantation, the soil in that area is probably unsuitable for the tree species which you used.

Underplanting

Planting under the shade of existing forest has usually resulted in failure, especially with the light-demanding larches and pines. Although both spruce and white pine grow poorly under heavy shade, they may do well under light aspen or gray birch cover. Usually the best way to grow trees on cutover land and grazed woodlots is to fence out cattle, keep out fire, and let nature do the seeding.

Interplanting

In old fields and pastures that are partially but slowly being reforested by natural seeding, you can fill in open areas by planting. This applies in general to areas not more than one-half covered with young trees. Do not plant closer than 10 feet to young trees already present, nor closer than 30 feet to the edge of a woodlot. Where the natural seeding covers over half the area, competition of older trees may be too great for planted trees to survive in the smaller openings; let such areas reseed naturally.

Assistance Available

Planting Stock

THE State of New York encourages forest planting by supplying trees from its nurseries at less than cost. As has been pointed out, Forest Practice Act

cooperators may obtain trees without charge unless they are to be used for Christmas trees. At least 500 trees per acre must be left for the future production of wood crops in order to qualify for free trees for Christmas-tree plantations.

Aids in Tree-planting

The Agricultural Conservation Program of the United States Department of Agriculture provides for federal cost sharing with the farm landowner in the "initial establishment of a stand of trees or shrubs on farm land for erosion control, watershed protection or forestry purposes." In New York State the extent of this cost sharing at present is a payment of \$10 per 1000 trees or shrubs planted. Replanting is eligible for cost sharing only where the original planting has been destroyed by drought, fire, or some other catastrophe. Consult your local Agricultural Stabilization and Conservation office for the details of this program.

To promote the establishment of cover for wildlife, limited federal funds have been provided through the New York State Conservation Department, Division of Fish and Game. This program has been modified in recent years and may change in the future. Consult your local Soil Conservation Service, District Forester, or District Game Manager.

Aids in Fencing the Plantation

To encourage the fencing of newly established plantations, the Agricultural Conservation Program in many

counties provides for cost sharing. A payment of 40 cents per rod of fence constructed is made with the exception of boundary or road fences.

Tax Aid

Reforested area may be "classified" under a legislative act of 1931, if it is more than 15 acres. Such land is assessed without regard for the increasing value of the trees on it, and at a value never more than that at which it was assessed at the time of classification. At the time at which the forest is harvested, the owner is required to pay 6 percent of the stumpage value as a tax. Further details should be obtained from the New York State Conservation Department at Albany.

Advice

Public agencies provide technical advice for those wishing to carry out reforestation. This bulletin, for instance, represents an effort of the Extension Service to supply you with helpful information. "On-the-ground" assistance is available to Forest Practice Act cooperators through the District Forester of the New York State Conservation Department on the selection of species and the planting and care of the plantation.

Care of Plantations

FOREST plantations cannot be expected to take care of themselves. Protection from fire, grazing, and tree pests are immediate concerns.

Fire is the worst enemy of young plantations, and even a light grass fire may kill all the planted trees. Fires are most likely to occur in the spring before the vegetation turns

green or in the fall after the annual vegetation dies. Fire danger is greatest along public highways.

Fire protection is based on care and prevention. Watchfulness at times of extreme danger and careful neighbors are perhaps the best safeguards. If the danger is particularly great along roads, you may plow from three to six furrows between the road and the plantation. Harrow this firebreak two or three times a season to keep down grass and weeds. Large plantations should be separated into blocks of 10 acres or less in size by leaving space large enough for fire lanes and roads.

Protection from grazing is necessary to prevent browsing and trampling new trees. Also, compaction of the soil may hamper future development of the plantation. If the land is valuable for pasture, do not plant it.

There are many tree diseases and insects. Damage is often greatest where the trees have been planted on the wrong site and growth is poor. Vigorous trees of certain species are also attacked, especially by the white pine weevil and the European pine shoot moth. Some of the more important tree diseases and insects are discussed in the description of tree species (pages 29 to 31). Control measures for specific problems are obtainable from your County Agent, District Forester, or Extension Forester.

Animals and insects go through periodic cycles of high and low populations, which greatly influence the damage to newly established planta-

tions. The mouse population normally reaches a high point every four years. You can either poison the



Figure 16. The white-pine weevil, which attacks not only white pine but also Norway spruce, kills the leader and thereby causes a deformity in the stem.

mice or wait for the population to decrease the following year. Large animals which move around considerably, such as deer, must be controlled over a large area by regulating the deer harvest.

In addition to protection, your plantation needs cultural treatment in later years. The amount of treatment depends on your aims, the species, the planting site, and the spacing of the trees. The development of quality timber products requires weeding out the competing hardwoods, pruning off the lower branches so clear lumber can be grown, and thinning out trees to maintain the proper rate of growth. This subject is only briefly treated here, since it is covered in detail in other handbooks.⁸

Weeding the new plantation to get rid of competing vegetation, usually hardwoods, is best done with chemicals. Some plantations need no weeding, while others may need release when five to ten years of age. The cost may be only \$5 to \$10 per acre for most conditions, half of which is the cost of the chemical.

⁸ *Care of Forest Plantations on Farm Lands*, by F. E. Winch, Cornell Ext. Bul. 867, 1952.

Pruning future sawlog trees to a height of 17 feet is usually done on 150 to 200 trees per acre. This is best done when the tree diameter is 3 to 4 inches, and at two or three different times. For example, in a red pine stand, half the pruning (lower 9 feet) might be done at age 12 to 15 years, and the other half a few years later. This pruning takes about ten minutes per tree when done at the proper time. Therefore a total of three or four man-days are needed to complete one acre.

Plantation thinning depends a great deal on the spacing of the trees. If your plantation is set 6 by 6 feet, it may need to be thinned at 15 years at a cost of two-thirds to three-fourths the cost of pruning. Furthermore, it is likely there would be no return from sales of the product. A plantation set 10 by 10 feet, on the other hand, might yield enough saleable products to pay for the first thinning.

In New York State, the Agricultural Conservation Program of most counties provides payments for the killing or removal of competing undesirable vegetation and for the thinning of young plantations up to 15 acres per farm.



Figure 17. A successful 17-year-old plantation of red pine that has been thinned and had the crop trees pruned

Tree Species and Major Enemies

White Pine (*Pinus strobus*)

White pine is the most valuable tree for lumber where it escapes the damage of the white pine weevil. It makes good growth on moderately moist, acid to slightly alkaline and fertile soil, drained well to a depth of at least 2 to 3 feet. It often grows on imperfectly drained soil. Its distribution is statewide, but it is best suited to northern counties. White pine should not be planted on very dry sands nor in excessively exposed areas.

Enemies. White-pine-weevil larvae bore into the stem at the top of the tree, causing the leader to die back. One or more of the side branches turn up to replace the leader, but a permanent crook or fork is left in the tree stem. Several weevil attacks are common and often leave the bottom log hopelessly deformed. Weevil damage is less in the Adirondacks. Current research shows that lead arsenate and DDT sprays can control this pest.

White pine blister rust produces stem cankers that kill the tree by girdling. It is controlled by eradicating currents and gooseberries, the alternate carriers of the rust, from the plantation and the vicinity. The State Conservation Department assists the Federal government with control measures in plantations of 5 or more acres.

Red (Norway) Pine (*Pinus resinosa*)

Red pine is useful for many purposes, is easily established and fast-growing. This tree has come to be planted more than the white pine. It grows well on acid soil, drained well to a depth of at least 3 feet. Red pine is adapted to fairly light, dry soils, but will grow on heavier soils if thoroughly drained.

Enemies. European pine shoot moth deforms tree by destroying the terminal buds. It is so prevalent in the lower Hudson Valley and on Long Island that red pine should not be planted. It is serious also in some of the western part of the State, particularly in the Ontario lake plain.

In southern New York the *Matsucoccus* scale has seriously damaged several plantations.

Austrian Pine (*Pinus nigra*)

Austrian pine, introduced from Europe, is similar to red pine. It grows well on deep, well-drained, medium to heavy soils of low acidity. It is in demand for Christmas trees in western New York. Although somewhat susceptible to the European pine shoot moth, it is hoped that Austrian pine may replace red pine in the lower Hudson Valley, on Long Island and on the Ontario lake plain.

Scotch Pine (*Pinus sylvestris*)

Introduced from Europe, and primarily planted for Christmas trees and erosion control, Scotch pine is very hardy and grows well on many soils, especially in early years. Later growth is best on deep, well-drained acid soils. It is second only to Jack pine in adaptability to dry soils and blow sand. Needle color varies with seed source, and this influences Christmas tree demand. Most older trees have crooked stems, but the slower growing "Riga" type is much straighter. The blue-green variety has been called "Boonville" type.

Enemies. Scotch pine is similar to red pine in susceptibility to European pine shoot moth. Pole-size trees suffer from snow breakage in the northern part of the State. It is one of the most susceptible species to damage by mice. White pine weevil attacks some plantations.

Jack Pine (*Pinus banksiana*)

Jack pine, native to northern New York, is the hardiest and least demanding of the pines, it is used on blow sand, dry rocky slopes, and other adverse areas for erosion control. It grows fast in the first 10 years and makes a quick ground cover. Later growth depends on good drainage and acid to slightly alkaline soil.

Enemies. Pine sawflies.

Larch, Japanese (*Larix leptolepis*) and European (*Larix europaea*)

The Japanese and the European larches are the fastest growing trees for planting, and are especially good trees where competition from hardwoods is a problem. Given a head start, height growth may be as much as 3 feet a year and may beat out that of most hardwoods. Both species are similar, but Japanese larch produces a little more volume and has better stem form. These introduced trees are unlike the native tamarack which grows slowly and inhabits wet areas. Acid soil of medium moisture content and fertility and drained well to a depth of at least 2 to 3 feet is best. These larches do not do well on dry sandy and gravelly soils or wet soils. Unlike other conifers, larch drops its needles in the fall and new growth comes very early in the spring. Planting should be done before the foliage comes out in the spring and after the needles drop in the fall. Use Japanese larch or the Cranston or Sudeten strains of European larch. The Dunkeld hybrid looks especially promising.

Enemies. Early growth is susceptible to late spring frost damage, so plantings should not be made in low areas and frost pockets. Larch case bearer and larch sawfly cause defoliation and slow growth, but are not usually serious enough to deter the planting of larch.

White Spruce (*Picea glauca*)

White spruce, a native of New York, makes slow early growth and thus a compact form desirable for Christmas trees. It is valuable for pulpwood and lumber. White spruce does best on well-drained acid soils with good year-around moisture and fertility. Lower slopes protected from drying winds are most suitable.

Norway Spruce (*Picea abies*)

Introduced from Europe, the growth of Norway spruce slightly exceeds that of white spruce. It is especially good for farm windbreaks and pulpwood. Its soil requirements are similar to those for white spruce but Norway spruce requires a little better drainage and fertility.

Enemies. The white pine weevil is serious, especially in the Adirondacks, but growth from lateral buds on terminal shoot permits recovery with less damage than in white pine. Late spring frosts cause damage in low areas or frost pockets. Spruce gall aphids can be a serious pest in Christmas-tree plantations but can be controlled. Cytospora canker is serious on some older stands.

Douglas-Fir

(*Pseudotsuga menziesii*)

Douglas-fir, the most important timber tree of western North America, is planted only as a Christmas tree or windbreak in New York. Rocky Mountain and Interior British Columbia strains are used; Pacific Coast strains are not hardy. It does best on well-drained soils of

average fertility and moisture.

Enemies. Extreme susceptibility to late-spring frost damage requires great care in the selection of the planting site. High ground with good air drainage is best. Ridges, the upper half of steep slopes, north-facing slopes, and sites with woodland protection are suitable. The fruit belt regions of western New York and the Hudson Valley, where the danger of late frosts is at a minimum, are good planting areas. Other parts of the State are suitable, even at the high elevations in the Southern Tier, if protected from late spring frosts.

Two needle diseases, Adelopus and Rhabdochline, may threaten some Christmas-tree plantations. Mice sometimes girdle trees. Some heavy deer damage is reported.

White Cedar (*Thuja occidentalis*)

White cedar is seldom planted because of its slow growth. It is one of the few trees adapted to both very acid and alkaline soil. Good growth, however, requires fairly good fertility and well-drained soil.

Enemies. Deer and several insect enemies such as leaf miner.

Black Locust

(*Robinia pseudoacacia*)

Black locust, excellent for fence posts, makes good growth on well-drained soils with at least medium fertility; near neutral to alkaline.

Enemies. The locust borer girdles and kills, especially non-vigorous trees on acid soil. Leaf miner is serious in some areas.

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